Technological Nature: Adaptation and the Future of Human Life
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Through creating and using technological nature, we are changing long-standing patterns of interaction that have existed for tens of thousands of years. Is that a problem? Some people say "No, it's not a big deal." At the core of their argument usually lie three claims, which sound something like this: (i) "We'll adapt." (ii) "Adaptation is how we evolved." And (iii) "Adaptation is good for us." The first claim is true. We will adapt. It is that or we will go extinct, and I doubt that will happen. The second claim is also true. Adaptation is part of our evolutionary heritage. But the third claim is not always true. It is possible to adapt and then to diminish the quality of human life, if not suffer. Let us imagine, for example, that all of us were put in prison for the rest of our lives. If we did not die straight out, and most of us would not, we would adapt to our new environment. We might get fatter from lack of exercise. We might become more violent. We might shut down emotionally as a way to cope, and hardly be aware of it.

How will we adapt to technological nature? How can we make wise choices in directing its creation and how we use it, now and in future years?

So far in this book, there have been three parts to my answer. First, I have argued (chapters 1–2) that we need rich interactions with nature for our physical and psychological well-being, but that we are losing those interactions because we are quickly and pervasively degrading if not destroying large portions of nature, which are required for such interaction. Second, I have presented and discussed my collaborative research on the psychological effects of experiencing technological nature (chapters 4–10). Taken together, this body of research suggests that technological nature is better than no nature but not as good as

actual nature. Third, in my account of environmental generational amnesia (chapter 11), I have suggested that through the loss of experience with actual nature, and the increase in technological nature, the baseline for what counts as a healthy environment, and healthy psychological functioning in that environment, will shift downward, as it has already, as each generation constructs a new, more impoverished baseline of what is normal. Environmental generational amnesia is a form of adaptation. Each generation adapts psychologically to a new environmental baseline.

Humans adapt to their environments, however, in many different ways. The adaptations can involve different processes and mechanisms, occur at the level of an individual, culture, and species, and have consequences that last for seconds to many thousands of years. Thus, to understand how we will adapt to technological nature, we first need to venture into difficult conceptual territory that involves what adaptation is and how it works.

Adaptation Is Not by Itself Normative

Many people tend to believe that adaptations are good and lead to better biological systems. They likely believe so because that is how adaptations often appear to work. For example, when we enter a darkened area, the pupils in our eyes adapt by dilating; when we then reenter a brightened area, the pupils adapt again by constricting. In the summer, people with fair skin tan, which is the body's way of adapting and thereby increasing its resistance to harmful ultraviolet radiation. Muscles adapt to strenuous efforts and get stronger. When we go to higher altitudes, our bodies adapt in terms of changes to our breathing, blood hemoglobin, and tissue metabolism. In hot conditions our bodies sweat to regulate their core temperature. Our bodies adapt when we change time zones. Entire cultures adapt to their climates. In the arctic, for example, we see more of a stocky and fat body type, which has been adaptive, as that body type helps to conserve heat.

Some of these examples draw on a biological evolutionary conceptualization of adaptation: Genes that lead to body types or behaviors that enhance survival tend to reproduce themselves, and thus these genes and correlative behaviors grow more frequent. For example, in the above

example of arctic cold, it would be hypothesized that people born with a stockier and fatter body type had a slighter better chance of survival in that climate, and thus over time, that body type tended to prevail. In chapter 2, I discussed how Wilson (1984) uses this biological adaptive explanation to argue for the existence of biophilia. Namely, certain affinities for nature (such as for water and plants) and fears of nature (such as of snakes and heights) increased people's chances of survival, and thus those affinities became more prevalent in our species.

It is true that biological adaptations can be good for us, as humans. But it is essential for us to understand that such adaptations can also be bad for us, or simply neutral. I would like to develop this idea.

First, we should set aside any thought that adaptations lead to *moral* goodness. To think so would be to commit what in moral philosophy goes by the term the *naturalistic fallacy*. Its specification is often credited to Hume (1751/1983) and Moore (1903/1978). The fallacy can be stated simply. "Is" does not equal "ought." For example, let us for a moment agree with Freud (1930) that "aggression is an original, self-subsisting instinctual disposition in man" (p. 77). That biological quality by itself would not establish the moral justification for its expression, such as for killing one's neighbor to gain his property. Another example is that in the 1930s Nazi Germany appeared to be adapting quite well to the world environment; but such success in their adaptation did not make that adaptive behavior morally right. Similarly, when Europeans came to the United States, they wiped out most of the Native American populations and took their land, and in the centuries since have successfully adapted to the new land; but that adaptation does not by itself establish the moral legitimacy of the invasion and the killing of many native people. In short, if you want moral justification you have to do something more than simply establish the existence of a trait or behavior that has been adaptive.

Morality aside, adaptations can be not only good but bad for the biological system. In the previous chapter, I discussed a study by Evans, Jacobs, and Frager (1982) that found that people who live with a certain level of air pollution for an extended period of time become desensitized to that pollution, and less readily recognize that such pollution exists. Imagine, then, that we had grown up in a rural area with clean air and then as adults moved to a dense, noisy, and polluted city, such as Los

Angeles. Over time, we would become desensitized to, and in this sense adapt to, our new polluted environment; but that environment would still be harming our health. Imagine, now, that we then took up residence close to a noisy freeway in Los Angeles. Perhaps initially we would have trouble falling asleep at night. The noise would be too loud. But over time we would likely get used to it, and in this sense adapt to it, and hardly notice the noise. But that does not mean that the noise would still not act as a stressor on our biological systems. I noted earlier that if we were forced into a prison for the rest of our lives, we would adapt to that new environment, but we would not enjoy it, and we would fare worse than we do now—much worse. Another example is that some people eat fast food corporate style: French fries, Big Macs, Whoppers, chicken nuggets, bacon-burgers, sodas, milkshakes, fried chicken. They like the taste of this food. They need it. Their bodies have adapted to this food. If they do not eat it regularly, their bodies call out for compliance. But as we all know, fast food is not good for human health.

I am saying that one misconception people sometimes have is that adaptation to the environment is always good for the biological system. It is not. A second misconception is that although an adaptation might be harmful for any particular individual in a society, adaptations are always good for the society at large. But that also is not true. For example, we can get used to bad traffic in our urban environments, but such traffic can still be stressful for millions of people, waste time, cost money, and contribute to air pollution and global warming. In other words, that traffic that we are getting used to is not good for society.

Even when adaptations seem good for a society, the question needs to be asked: "Over what time frame?" It can happen, and often has, that the adaptive behaviors that allow a culture to thrive for 100 or 1,000 years are the very behaviors that cause their demise. For example, as I described in the previous chapter, humans arrived on Easter Island by 900 CE, and they adapted quite readily to the subtropical forest they encountered. As part of their adaptive behavior, they extracted natural resources at an unsustainable rate. The upshot was that although that behavior was highly beneficial to the individuals and people of Easter Island over some hundreds of years, because their behavior was not

sustainable, it led first to hard times and then to horrible times, during which many people practiced cannibalism to survive, and finally it led to the end of them as a people. Thus what might look like a good adaptation from a shorter time frame can look bad from a longer one.

Adaptation: What Is It?

How then do we know if an adaptation is good, bad, or neutral? Part of my answer above is that the answer can vary depending on the time frame under consideration. I will come back to this idea in the next section. Another issue I will address later in this chapter is what exactly counts as a "harm." But before addressing both ideas—how long harms last and what counts as a harm—first we need to tackle a more fundamental question: How exactly do we define the term "adaptation"? Unfortunately, there is no easy answer. As Siegler (1996) writes: "Adaptation is perhaps the single central organizing idea in modern evolutionary theory. . . . This is true despite the concept being almost as difficult to define in biological as in psychological contexts" (p. 26).

Merriam-Webster's dictionary ("Adaptation," n.d.) provides a worthwhile starting point. It defines adaptation in two ways. One way simply refers to an organism's "adjustment to environmental conditions." This definition says nothing about whether the adjustment benefits or harms or neutrally affects the organism's system. The second way casts the adjustment positively, as "modification of an organism or its parts that makes it more fit for existence under the conditions of its environment." But as I sought to establish in the previous section, adaptations do not always lead to greater fitness. Thus, in my view, Webster's first definition has the most merit. Adaptation refers to an organism's adjustment to its environment and makes no normative claim.

We still, however, have not said too much insofar as there are many ways that a system adjusts (adapts) to environmental conditions. Homeostasis is one form of adaptation wherein an organism seeks a stable "normal" state, while being able to handle some minor variation. Our bodies, for example, seek to regulate their internal temperature to one that is normal (e.g., 97.8 degrees Fahrenheit). Sometimes a body is hotter, especially when it is fighting a disease with a fever. Other times the body's temperature might drop a little lower. But sooner usually than

later the temperature comes back to normal. Something like this process occurs when we travel to different time zones and our bodies adjust our internal clocks to match the sun's circadian cycle. One difference here, however, is that it is also possible to decide not to adjust to the circadian cycle, as do people who work night shifts. But even then the body usually performs better sleeping at night and being awake during the day. Some form of homeostasis is involved in acclimatization, when a body seeks to normalize its breathing, blood hemoglobin, and tissue metabolism when it changes altitudes. If the altitude increases too much, the adjustments are not fully successful insofar as a new and impoverished baseline gets established. Although people can live their lives with that new baseline, they are poorer for it—in terms, for example, of how fast wounds heal and the capacity for physical exertion. Over many generations a different form of adaptation can occur, and a people can change genetically to function "normally" at higher altitudes, as have the Sherpas in Nepal. But there are obvious limits. No one could presumably adapt to living their lives at elevations equivalent to the top of Mt. Everest.

Addiction is also a form of an adaptation. Webster (1973) defines addiction as "a compulsive physiological need for a habit-forming drug (as heroin)." But what counts as a drug? We would all agree about heroin. How about tobacco? Caffeine? Are people addicted to Ibuprofen if they use it daily to manage low-level pain in their body? Does it make sense to say that some people are addicted to chocolate? To Big Macs? To soda? All of us have a compulsive physiological need to eat food. Are we addicted to food? People have also used the term "addiction" to speak about compulsive needs not just to drugs or ingestible items but to forms of activity. People speak, for example, of an addiction to gambling, especially when there appears to be something compulsive to the behavior. But how far are we willing to go with this move? Do we also want to speak of an addiction to shopping? An addiction to following one's football team? An addiction to falling in love? With all of these questions, notice what happened. We started with a term that specified the parameters of a form of adaptation: addiction. The specification initially seemed straightforward. We all agree that people can get addicted to heroin. But then the boundaries of the definition quickly got blurred.

The same thing happens with the term "habituation." Webster offers two definitions. The first overlaps substantially with addiction: "tolerance to the effects of a drug acquired through continued use." Thus, as they did with addiction, blurred boundaries emerge with this definition. Would we say, for example, that we become habituated not just to chocolate or fast food, but food in general? If so, we are not saying very much. If we want more specificity, then we need once again to demarcate what counts as a drug, which is not easy to do. The second definition is very broad: "the act or process of making habitual or accustomed." Drugs aside, clearly we adapt to our environment all the time in this way. We become accustomed (habituated) to sitting through Sunday morning church or long Passover Seders, to army life, to bad traffic, to an abusive relationship, to sunny days if we live in Phoenix and rainy days if we live in Seattle, and to the fast flow of information over the Internet. Taken this far, we become habituated to virtually anything and everything within a normal range in our experience. Psychologically, it is also possible to become habituated or acclimated to difficult events outside a normal range of experience. For example, think of an individual who progresses through a life-extracting disease, such as AIDS. Over months and often a handful of years, the individual succumbs to increasingly awful physical states, and at each of those degraded physical states, the mind needs to adapt in the sense of readjust.

Adaptation takes on a different meaning when applied to a child's cognitive development. According to Piaget (1983), a child brings to new situations an existing way of understanding them, and in this sense seeks to assimilate the new to the old. But that process never works completely, so the child also needs to accommodate to the new. Sometimes the accommodations are not successful. At that junction, the child is disequilibrated, recognizing the problem but not the solution. Thus, according to Piaget, toward seeking equilibration, and through interaction, the child reorganizes existing structures of knowledge to take account of the new and previously discrepant information. Notice, then, that in this account of the equilibration of cognitive structures the psychological system does not seek homeostasis in terms of an original state (as occurs with the body's homeostasis around its normal internal temperature) but in terms of new and more comprehensive and adequate psychological structures.

This account of disequilibration and the construction of knowledge grounds the speculative thoughts I offered in chapter 8. Recall that I had said that children in the coming decades will be interacting with a new form of an artifact that has never existed before in human history—one that is technological but seemingly autonomous, goal-directed, personable, and social, and perhaps even moral: personified robots. Since children's conceptual categories emerge not simply by maturation but through interaction with the environment, I then speculated that children will construct new ontological categories of knowledge. In other words, in the classic Piagetian telling of equilibration, the child's developing mind constructs categories that are already fully established as core knowledge that adults have. But in this new telling of the equilibration, the child's developing mind—as it adapts to the new technologies—will construct new categories of knowledge that all of us who are old enough to be reading this book do not and will never have.

As I have described these different forms of adaptation, it might appear as if they always occur in isolation from one another. But often they are combined. For example, the adaptation that is involved with environmental generational amnesia has aspects aligned with equilibration, habituation, and homeostasis. It is aligned with equilibration insofar as it depends fundamentally on the child's construction of knowledge through interaction with the physical world. It is aligned with habituation and homeostasis insofar as the psychological system seems strongly committed to the "normalcy" of the baseline that is constructed in childhood.

In summary, I have suggested that it makes the most sense to define adaptation in terms of an organism's adjustment to its environment, and that such adjustments can help or hurt a biological system, or both help and hurt, or neither. In other words, adaptation is not in itself normative. Then, without attempting to be comprehensive, I showed that adaptations occur through homeostasis, acclimatization, addiction, habituation, equilibration, assimilation, and accommodation. These different constructs provide rich accounts of different ways that humans adjust to their environments; yet the constructs themselves often seem to share overlapping and underspecified processes and mechanisms, and to comprise poorly defined criteria for bounding the application of the construct.

What's So Bad about Being a Dog Anyway? or, How Long Do Harmful Adaptations Last?

Earlier I said that what might look like a good adaptation from a shorter time frame can look bad from a longer one. Thus, our next step—toward answering the question of how we will adapt to technological nature—is to try to bracket what some of these time frames look like. Here, then, are five time frames that I find useful for the discussion at hand. I should say at the outset that I have little vested in the number of levels or the spans of time within each. If the reader prefers to rethink this broad typology with different levels and time frames, that is fine, as my point is more to lay out the structure of the argument than to commit to the specifics of it. I also remind the reader that I have not yet specified what counts as a harm, and I am for now emphasizing physical harms (such as pain, sickness, and death) because of their prima facie validity.

Level 1: Harms Last from Milliseconds to No Longer Than About One Month

Many of the adaptations noted above have harms of this duration. For example, when we move from a darkened room to bright sunlight, it hurts our eyes, and our pupils constrict. The harm is in terms of our initial pain. The pain lasts on the order of seconds. When we fly halfway around the world, we experience the harm of jet lag. Within a few days or a week our bodies adapt and the harms disappear. Similarly, when we proceed quickly from lower to higher elevations, from, say, sea level to 10,000 feet, most people experience the harms of altitude sickness. Within a day or at most a week, our bodies adapt and the harms disappear. Notice what happens when we ask the question: Is it harmful for the body to adapt as it moves quickly from a darkened environment to one that is bright sunlight? The answer is yes and no. It is harmful (as in a little painful) over the duration of some seconds, and it is not harmful past that. Similarly, we can ask the question: Is it harmful for the body to adapt as it moves quickly from sea level to 10,000 feet? Again, the answer is yes and no. It is harmful (at least to most bodies) over the duration of a day, and it is not harmful past a week.

Level 2: Harms Last between One Month and a Lifetime, but Future Generations Experience No Harms

When wild animals are brought into captivity (as in a zoo), they often exhibit "neurotic" behavior: for example, a large cat can pace for hours each day in its cage, and an elephant can stamp its foot for hours each day in its cage. These are harms to biological entities that can last a lifetime. Often because of these harms it is difficult to get wild animals to breed in captivity. But when breeding is successful, and the next generation is born into captivity, that next generation often adapts much more easily to their captive environment. The same can occur with humans. It can be difficult for people who grew up rurally to adapt as adults to a dense crowded urban environment. In some ways, they may be like the wild animal in the zoo. But their children will likely have few of the same difficulties as their parents. Using our earlier terms, the parents are unable to habituate to their new urban environment, whereas their children, born into that environment, habituate at a young age. We can ask the question: Is there a harm when people move from rural to urban environments? If for the moment we assume the harms are of the form I noted above, then the answer is yes and no. It is harmful to the parents for the entire duration of their lives. But it is not harmful to their progeny across future generations.

Level 3: Harms Last between 1 and 10 Generations

Plagues offer one of the clearest examples of harms at this level. Throughout history, epidemics have wiped out large percentages of a people within a few years, or even a week. But then over a period of years—without any medical vaccines—resistance to the disease builds up within a society, and the disease either substantially diminishes or disappears altogether. For example, between 1485 and 1551 the highly contagious English sweating disease struck England and parts of Europe, and then "it vanished as swiftly as it had come" (Dubos 1965/1980, p. 187). During roughly the same time frame, syphilis spread through Europe at an astonishing rate, and then decreased (Dubos 1965/1980). One of the deadliest pandemics in human history was the Black Death, which killed around 75–100 million people. In the fourteenth century, it is estimated that in Mediterranean Europe, Italy, the South of France, and Spain that the Black Death killed 75–80 percent of the population. In Germany and

England, the number was probably closer to 20 percent; in Egypt, about 40 percent; in Iraq, Iran, and Syria, about 33 percent ("Black Death," n.d.). Most of the damage was done within about four years, at which point the plague largely retreated, although it is believed to have returned more locally every generation for several hundred years. In 1665 in London, for example, the Black Death erupted and killed at least 100,000 people. By the 1700s, however, even such local outbursts subsided. For all of these plagues, there is a common adaptation account. People who were particularly susceptible to the disease got it, and they either died or lived and built up immunities to it. Most died. The children of those people who lived thereby had a genetic predisposition to be resistant to the disease. It is a classic case of biological evolutionary adaptation.

The reason I chose 10 generations for the outside mark of a Level 3 harm is that if we think of the Black Death as the worst plague in our recorded history, and if it lasted roughly 200–250 years (although only about 4 years at its worst), and if each generation spans roughly 20–25 years, then 10 generations roughly accounts for the length of this plague. After 10 generations, this plague caused us as a species no further harms. None at all. It was not due to medical science coming up with a vaccine or a cure. It was due to biological adaptation.

Now we ask the question: Are plagues harmful? Once again the answer is yes and no. They are tremendously harmful over the short and medium term (Levels 1–3). They kill many people. But they are not harmful to us as a species over a longer time frame.

Level 4: Harms Last between 10 and 500 Generations

Humans are susceptible to a huge number of diseases. For example, we can be struck with ulcers, diabetes, allergies, chicken pox, hives, lupus, syphilis, psoriasis, ringworm, basal cell carcinoma, AIDS, migraine headaches, cholera, genital warts, gonorrhea, shingles, gout, herpes, measles, scarlet fever, smallpox, thrush, typhoid fever, and Alzheimer's disease. We can also be born with or come to have many physical disabilities. We can have poor eyesight, poor hearing, a cleft lip, or a weak heart. We could end up with cerebral palsy or multiple sclerosis or muscular dystrophy or Parkinson's disease. We could be born with Down syndrome. For some of these diseases and disabilities, we now have medical cures and technological solutions. For example, for most people

with poor eyesight, the solution is very simple. They wear glasses and they see normally. People with poor hearing can wear hearing aids. Surgery can partly correct for people with weak hearts. Insulin can help people with diabetes. We have reasonably effective vaccines for many diseases such as chicken pox, hepatitis, tetanus, mumps, measles, tuberculosis, and typhoid. And so on.

The short of it is that without medical and technological assistance, many of us would not have been born because our ancestors had defects that would have killed them before their childbearing years, or we would have died before now due to our own defects. As Dubos (1965/1980) writes: "It is to be expected that medical advances will modify the hereditary structure of prosperous populations by permitting the survival of persons with genetic defects who in the past had little chance of reproducing their kind" (p. 248). Thus, as we use our technological minds to help us and others as individuals, we as a species diminish our natural capabilities and become increasingly reliant on technology to survive. In this way, over the long term—roughly 10–500 generations—as we care for specific individuals we harm ourselves as a species.

Within this longer time frame, and because of the construction across generations of a shifting baseline, we as a species will unfortunately not recognize many of these harms as harms. This mechanism underlies my account of environmental generation amnesia in the previous chapter. Instead, we will largely think of these conditions as the normal human condition. Even today we do so. For example, I doubt any of us is ever surprised or particularly concerned to see others or ourselves wearing eyeglasses. As Dubos (1965/1980) writes: "Any disease, or any kind of deficiency, that is very widespread in a given social group comes to be considered as the 'normal' state and consequently is accepted as a matter of course within that group" (pp. 250–251).

Level 5: Harms Last Over 500 Generations—or Disappear

The average size of a gray wolf's territory is about 77 square miles. The wolves, as a pack, cover about 15–30 miles a day (about 9% of their territory) in search of prey. When chasing prey, a gray wolf can reach speeds approaching 40 mph, bounding as much as 23 feet at a time. The wolves communicate the boundaries of their territory to other packs somewhat by scent marking and principally by howling ("Gray Wolf,"

n.d.). Now imagine a gray wolf held captive in a zoo, pacing from one end of its cage to the other repetitively for hours on end. It is hard to escape the interpretation that the wolf in a zoo is living an impoverished life.

Over the last 15,000 years, a form of the wolf has been domesticated. This form of wolf has changed genetically. We no longer call this domesticated wolf a wolf. It is now "man's best friend" and goes by the name of "dog." Does the dog suffer by not being a wolf? No, because the benchmarks have changed. Do we suffer because we are no longer single-cell prokaryotes or *Homo habilis*? No, because an organism's well-being needs to be evaluated based on its capacity for flourishing for the species it is, not the species it once was. Now we ask: If over 500 generations (or pick whatever time frame you think it would take) we adapt to impoverished environmental conditions in such a way that we change as a species, in terms of our genotype and phenotype, will we be harmed? Following the logic of the argument, the answer would be no.

Notice, then, the difference between a Level 4 and Level 5 harm. In a Level 4 harm, we are harmed but do not necessarily know it because of the shifting baseline and resulting generational amnesia. The benchmarks are tied to the organism's physical and psychological capacity, and that capacity is independent of whether or not the organism correctly knows what that capacity is. In a Level 5 harm, the organism can fundamentally change and become another species, at which point the benchmarks change and the harms disappear.

Imagine that we enslaved all the people of the world who had big noses, or white skin, or black skin. We can call this group People S (for Slaves). All People S would incur Level 1 harms. In the initial process of being enslaved, some People S would rebel, and they would be killed. Thus, those rebellious traits would start to be selected out of the population. Other People S would have children. Those children would be born into slavery, and thus would have an easier time than their parents adjusting to their enslaved condition. But still those children and their children and many future generations to follow would suffer in slavery. These People S would still yearn for freedom, autonomy, and self-governance, as enslaved people throughout the world always have. The story of Exodus is a story of an enslaved people yearning for and gaining such freedom. But let us say we could keep the People S enslaved

for hundreds of generations. Would there come a time—after 500 generations or 1,000 generations or more—when People S changed as a species and no longer wanted what we call human freedom, no more than a dog wants to be a wolf? If so, then at that junction the harms disappear.

What is so bad about being a dog anyway? Or a slave?

Can humans change into another species? If so, how long will it take?

What Counts as a Harm

In the previous section, I said that when we speak of possible harms to our future—caused by adapting to increasingly pervasive and sophisticated forms of technological nature, and to the increasing destruction of the natural world—that we need to be more specific about how long of a future we are interested in. Are we concerned about harms that last milliseconds to months? A lifetime? Ten generations? Five hundred or a thousand generations? Thus, I offered a typology of five levels of harm that specified duration.

Now we need to consider an equally important issue of what counts as a harm. As I mentioned earlier, for the most part I have been using examples that highlight physical harms, such as pain, sickness, and death, because of their prima facie validity as a harm. I recognize, of course, that not all events that appear as physical harms actually are harms. For example, when we use a needle to dig a splinter out of our foot, we cause a small physical harm to lead to a larger physical benefit. Would we call the pain caused by the needle a harm? Probably not when it is framed in this larger context. Similarly, people undergo the pain of chemotherapy, open heart surgery, and most medical procedures with the expectation of a greater physical benefit. Psychological benefits can also frame larger contexts that nullify the initial assessment of physical harms, as when people sometimes speak of a physical illness as a "blessing in disguise." Still, with all of that said, most of us most of the time will grant that physical harms are normatively not good.

At this junction, I would like to demarcate two types of harms: *direct harms* and *harms of unfulfilled flourishing*. Direct harms refer to physical, material, or psychological harms that a person experiences directly. Smash a toe, lose a hundred dollars, suffer a nervous breakdown—all

are direct harms. Harms of unfulfilled flourishing refer to physical, material, or psychological benefits that do not occur but could have and sometimes rightly should have. To incur this harm, it is not even necessary that the person who is harmed be aware of the harm. Imagine, for example, that, unknown to you, you were to inherit ten million dollars from a distant relative; but just after that relative's death a corrupt lawyer forges a new will and the inheritance goes elsewhere. Were you harmed? Not directly. You never even knew about the possibility. But you were certainly harmed in the sense that you were cheated out of your rightful inheritance. Or imagine a child who grows up without ever having been exposed to music; then as an adult he tells us: "I don't care for music at all; I never listen to it." We might say: "Oh my, you don't know what you're missing, for there is a beautiful repository of the musical experience that is within the range of all humans." We might say that this person's musical sensibility was stunted as a child, and in this sense this person experiences a harm of unfulfilled flourishing. Similarly, if as a result of difficulties in childhood, an adult becomes unable to engage in a deep loving intimate relationship with another adult, we might say that this person, too, experiences a harm of unfulfilled flourishing. Or imagine children growing up in a city of the future that is thick with air pollution, who are unable to exercise their bodies vigorously. These children would be harmed by never having experienced the flourishing of their physical bodies exerted in open space.

Some of the harms that occur as we adapt to changing environments are direct harms. I named some of them earlier, such as jet lag, altitude sickness, mental disorders from crowding, and death from plagues. But many of our harms—and the least recognized—are harms of unfulfilled flourishing. They are not always easy to recognize.

Here is one modest example. One of the rules in visiting Mammoth Cave National Park (as for many nature areas) is the following: "Take only memories, leave only footprints: all rocks, plants, animals, and historic artifacts in the park are protected; plants and flowers may not be picked, and animals may not be injured, killed, fed, or harassed. Please leave them here, as you found them, for others to enjoy" ("Mammoth Cave," n.d., para. 16). This rule—"take only memories, leave only footprints"—makes some sense if we want to prevent direct harms to an ecosystem. But it comes at a cost to the individual. Namely, there is a

simple but lovely form of interaction with nature, which often begins in childhood, that involves collecting small objects from places that one visits. Sometimes children build a large collection of such objects, and classify them, and study them. Such forms of interaction can set into motion a lifelong scientific inquiry into the natural world. Sometimes these objects, for children and adults, hold important memories of special times. The new "environmental" message—"take only memories, leave only footprints"—helps to prevent harm to an ecosystem, but it comes at a human cost, not large, but not so small either, by causing a harm of unfulfilled flourishing: the experience and satisfaction of collecting parts of nature.

A different harm of unfulfilled flourishing can be found in Diamond's (2005) account of how the Japanese in the 1700s solved one of their environmental problems: the overharvesting of their timber. Employing what Diamond calls a top-down management style, the local rulers, both the shogun and the daimyo, dictated who could do what in the forests, and where, and when, and for what price. Toward making thoughtful decisions, the rulers paid for detailed inventories of their forests. Diamond writes:

> Just as one example of the managers' obsessiveness, an inventory of a forest near Karuizawa 80 miles northwest of Edo in 1773 recorded that the forest measured 2.986 square miles in area and contained 4,114 trees, of which 573 were crooked or knotty and 3,541 were good. Of those 4,114 trees, 78 were big conifer (66 of them good) with trunks 24–36 feet long and 6–7 feet in circumference, 292 were medium-sized conifers (253 of them good) 4–5 feet in circumference, 255 good small conifers 6–18 feet long and 1–3 feet in circumference to be harvested in the year 1778, and 1,474 small conifers (1,344 of them good) to harvest in later years. (p. 301)

Diamond believes this form of management is exemplary. Granted, it was effective in preventing direct environmental harms caused by overharvesting timber resources. But now we can ask: Do harms of unfulfilled flourishing arise through interacting with such managed land where literally every tree has been counted, measured, graded, and fit into a harvest plan for eventual cutting? I think that such harms do arise. Dean (1997) writes that "an enveloping wild landscape . . . [is] central to our original understanding of the world and our rightful place within it" (p. 17). I developed this idea in chapter 1 in relation to the Ju/wasi of the Kalahari Desert. I wrote that wildness for the Ju/wasi did not just exist

facing off a lion with a burning branch. It was encountered—and still can exist for us today—while experiencing the migration of birds, the changing of the seasons, and heat and cold. Wildness is the freedom to move, and the strength to do so, and the land to do it in. Wildness is encountered through interacting with states that are vast, free, and self-organizing. If Dean's position is correct, and I argued in chapter 1 that it is, then perhaps by interacting with heavily managed landscapes we do not experience a sense of awe in the Other—that which exists outside of human domination. We do not experience a sense of humility. Perhaps it is reasonable to say that when we look at the Other and see only a reflection of ourselves, we have not fully experienced ourselves. We have not fully recognized our potential as individuals or as a species.

In chapter 4, I described how the plasma display window of nature came up short, in comparison to its glass window counterpart, in terms of its physiological and psychological benefits. I said then that the technologist can always provide a rebuttal of the form: "But the technology is not yet quite good enough." I said that that was a fair rebuttal, as far as it went, but that as technologists develop new technologies we need to put the technologies "to the test," and that the important question becomes, what tests? I then concluded that conceptualizing the right set of psychological benchmarks would lead to the right tests and constituted a critical endeavor for engineering technological nature for human good.

We are now in position to say more about the right sort of psychological benchmarks insofar as they comprise the above two types of harms: direct harms and harms of unfulfilled flourishing. Most of the harms I have focused on in my empirical research program on the psychological effects of interacting with technological nature have been direct harms, because these are the most tractable scientifically. The most notable exception occurred when my colleagues and I spent substantial efforts trying to establish some robust measures of creativity (chapter 4). Although we were not entirely successful, I thought at the time, and I still believe, that that endeavor represents an important one because it can function as a placeholder for an empirically tractable harm of unfulfilled human flourishing. But what if instead of just the benchmark of creativity, or the few others described above—such as collecting small parts of nature or interacting with unmanaged landscapes—we could

successfully map out hundreds of benchmarks for human flourishing in human–nature interaction? If that were possible, we would then have much of what we would need in terms of criteria by which to assess the psychological effects of technological nature in its current and future instantiations. That is the agenda I put forward in the next section.

A Nature Language—Benchmarks for Human Flourishing

Imagine the following situation. You live in a town with access to a beautiful river, and have on many occasions meandered down river off-trail over sharp rocks and small waterfalls to secluded spots of immense beauty. There is one pool in particular that takes effort and time to reach. You do not always have the time and energy to head there, but when you do, you feel yourself, with each step, pulling away from the busyness of the day and the comfort and safety of the town, and moving toward something less trammeled and more wild. You feel joy and also a little fear. It would not be a good time, for example, to twist an ankle. Hours later, on your return, you look forward to rejoining your family and friends in the comforts of your home in a domestic landscape. Now imagine—which is easy for me to do, because something similar has happened in my life—that people put in a quick access trail directly down to that river pool, so that within minutes anyone from town can enjoy the pleasures of swimming in that special spot. People make a strong case that their lives are busy and there is not always time to walk the long way down river. People also argue that it is elitist to restrict the river pool to those who have the time or the stamina to reach it. Perhaps they even mention that just yesterday they took some young children to that pool, using the quick trail, and that it was a joy to see the children connect to nature in such a way, and who would want to deny children such an intimate connection with such a beautiful nature spot in the world?

What can one say in response? One answer, of many, is that something deep and profound occurs in the human psyche as it moves out and away from human settlements. Often the mind quiets itself from social chatter; the senses become more alert because one is off the trail, finding one's own way, and because you know you need to keep yourself safe. It is not that one is antisocial. Not at all. It is that part of being

deeply social is to separate at times from the larger society, and then, from that stance of separateness, to rejoin society. Milton (1674/1978) writes in *Paradise Lost*: "For solitude sometimes is best society, And short retirement urges sweet return" (Bk. IX, ll. 249–250). It has been this way for *Homo sapiens* for tens of thousands of years as part of the life of the hunter-gatherer. This form of interaction with nature has also been, in some form, incorporated into virtually all cultures, as in the adolescent initiation rites among indigenous groups, such as the Dagara of Burkina Faso (Somé 1995). We can refer to this form of interaction with nature as *movement away from human settlement—and the return*. This movement can happen in small groups, as happened in ancestral times when small hunting parties would separate from the main group for one to five days at a time. This movement occurs perhaps most powerfully alone. When Jesus spent forty days and forty nights in the desert, he was not with a support group of other humans.

It was asked above by the advocates of the new river trail: Who would want to deny children intimate connection with beautiful spots in nature? But I think that question is framed incorrectly. First off, the question is part of a slippery slope. Why stop with a trail? Why not put in a driving road, with bus access, and make it wheelchair accessible? Why not put in roads to the top of Half Dome in Yosemite and to the base of Annapurna? Why not replace all trails in wilderness areas with roads, so as to make those beautiful spots accessible to all? Many people would object to such roads but do not see that after 50,000 years of expanding across this planet, we are closer than not to that road-full condition. But even setting aside the counterargument of the slippery slope, the trail advocate's question is framed incorrectly because it assumes that by granting easy access to places in nature we lose nothing in the process. But easy access deprives people of this opportunity to experience the movement away from human settlement—and the return. That trail causes a harm to people now and to future generations. It is a harm of unfulfilled flourishing. People may not recognize this harm. If that is the case, then it likely represents more evidence of the shifting baseline and the problem of environmental generational amnesia.

As we populate the planet with over 6 billion people and increasingly use our technological prowess to control if not destroy nature, or to

mediate it, as with technological nature, we are losing patterns of interaction with nature that have sustained us for tens of thousands of years, and which contribute deeply to our flourishing as individuals and as a species. As we lose these patterns of interaction, we are losing the very conceptualization and language to speak about that which we are losing.

Thus there is the need to generate what I am calling a *nature language*: a way of speaking about patterns of interactions between humans and nature, and their wide range of instantiations, and the meaningful, deep, and often joyful feelings that they engender. I believe the vocabulary of this nature language is partly comprised of hundreds of interaction patterns. The above vignette motivated one such interaction pattern: movement away from human settlement—and the return. One of my examples in the previous section comprises another interaction pattern: of collecting objects of nature. I structured chapter 1 around six broadly framed interaction patterns of the Ju/wasi of the Kalahari Desert. Namely, the Ju/wasi used their bodies vigorously. They experienced periodicity of the natural world and in the satisfaction of their physical needs. They had freedom of movement. Some of their desires were checked and balanced by the environment. They encountered the wild. And they cohabited with nature. I said at the end of that chapter that we should care about these interaction patterns because they point not just to our past but—in integration with our technological selves—to our future.

My colleagues and I are currently seeking to generate this nature language, based partly on conceptualizing and validating what may be several hundred interaction patterns (Kahn et al. 2010; Kahn et al. forthcoming). Other examples of possible interaction patterns include the following: traveling the winding path, traveling off path, the hunt, waiting, prospect, refuge, investigating, artistic expression, solitude, approaching carefully, in the flow of nature's dynamics, water on feet and hands, immersed in water, plunging into water, moved by water, playing, dying, gardening, foraging, tracking, combating the destructive forces of nature, using nature to find respite from nature, climbing, running, following the light through a thicket, around a campfire, and under the night sky. Each one of these possible patterns has stories attached to it, in the way that the pattern above (moving away from human settlement—and the return) had a story attached with it, that fleshed it out and gave it a meaning in context.

It is a hard project, and it may be another five years before we can say with conviction what this language sounds like in a comprehensive way. But it would be worthwhile here to describe a few more properties of this nature language, and what this project can achieve, if successful.

Our account of interaction patterns draws in part on Christopher Alexander's pattern work in architecture wherein, over decades, he and his colleagues generated 253 patterns in the built environment that they believe engender meaningful human living (Alexander et al. 1977). For example, one of their patterns is titled "light on two sides of every room." They write: "The importance of this pattern lies partly in the social atmosphere it creates in the room" (p. 748). They also write that this "pattern, perhaps more than any other single pattern, determines the success or failure of a room" because "when they have a choice, people will always gravitate to those rooms which have light on two sides, and leave the rooms which are lit only from one side unused and empty" (p. 747). For Alexander, and us, patterns are not rigid molds, as in those made by cookie-cutters where every cookie looks identical. Rather, patterns embody an underlying unified structure that allows for infinite instantiations. It is in this sense that Alexander (1979) writes that patterns always have a "quality without a name," which "let our inner forces loose, and set us free" (p. x).

So, too, with interaction patterns between humans and nature. The above pattern of moving away from human settlement—and the return does not specify where or how or how long or with whom. Each time it is different, unique, alive. Or consider a possible interaction pattern of *using nature to find respite from nature*. Thomas (2006) has a wonderful picture taken about 1950 of her family sitting with Bushmen in the Kalahari Desert. They are all sitting in the sand in a squiggly sort of circle. Thomas points out that the odd shape of the human configuration follows perfectly the shade from the tree above them. Similarly, this interaction pattern emerges in modern society when we step under a tree to find a brief respite from a thunderstorm or a hot summer sun; or when children sit in a groove among jagged forms of a rock in New York City's Central Park. Or consider a well-known and well-utilized interaction pattern from landscape architecture: the winding and countered path (Kaplan, Kaplan, and Ryan 1998). Such paths lead one forward in

anticipation of what comes next, and engender human interest and engagement. This interaction pattern can be instantiated in endlessly different ways. The paths may move like animal trails throughout a forest, or be constructed in an urban park or in a Zen garden. Rivers can be paths in this way as well. Walk up a winding river, and it is likely that your mind will say "oh just go one more turn around the bend, just to see what's next." Then you do. Then your mind says the same thing again: The interaction pattern is at work.

Notice another structural feature of an interaction pattern. The pattern is characterized not simply in terms of the physical features of the natural phenomenon (such as a winding river) nor simply in terms of the human activity (such as walking) but the specific interplay between both. Interaction implies human activity, often physical and always mental with external phenomenon. In turn, the interactions lead to meaningful if not profound emotions, such as of pleasure, contentment, joy, fear, companionship, surprise, delight, reverence, awe, humility. Sleeping under the night sky can fill one with awe, and walking in grizzly country can fill one with humility, fear, and reverence, in ways that no urban experience can.

Another fundamental idea about interaction patterns is that many of them can be instantiated in three categorically different ways: in a wild form, a domestic form, and a perverse form. As a case in point, reconsider the interaction pattern I described at the beginning of chapter 1: being recognized by a nonhuman other. It is a powerful and meaningful experience—one that people sometimes remember for a lifetime—of being recognized by an animal in the wild: perhaps getting within feet of a shark or a barracuda while snorkeling in ocean waters, or of surprising a mama bear and her two cubs while hiking in the forest, or even encountering a large buck in a meadow glen, and there is an instant of silent stillness where he looks at you and you look at him, and then his explosion of energy as he bounds into the forest. This interaction pattern plays out in domestic forms, too. Imagine coming home from work with a friend, and as you enter your house your beloved dog runs across the room and greets you but not your friend with a boundless welcome. Your dog recognizes you, and you recognize your dog. In chapter 1, I wrote that if we go to a zoo we can sometimes see a child, or even

adult, throwing food or a pebble at an animal, such as a lion, leopard, or great ape. The person is trying to get the animal's attention. I think throwing food or pebbles at a caged wild animal is a perversion of this deep need that people have to enact the wild form of this interaction pattern. It is such a deep need that even zoo signage, and zoo docents on the lookout, cannot fully stop zoo visitors from enacting this perversion.

So far, I have been speaking of interaction patterns as separate entities, but they usually coexist with many other interaction patterns, and dynamically bring forth many instantiations and experiences. As a rough analogy, think of an interaction pattern as a word in a language. Words have definitions. Words can be isolated. But words rarely exist by themselves. Usually words are combined to convey meaningful information and to bring forth ideas. Words can be combined in an endless number of ways. Similarly, although it is useful to generate individual interaction patterns to help gain clarity of their forms, we should not lose sight of how the interaction patterns mix and can topple on one another in our lived lives with nature.

Let us imagine that within five years we can establish 150 or 250 valid interaction patterns. They could then be used as psychological benchmarks to put technological nature "to the test." Using just the possible interaction patterns discussed so far, we could ask the following research questions: When interacting with a robot animal, can people enact the interaction pattern of recognition by a nonhuman other? Or does that recognition require that we attribute consciousness to the biological animal in a way that we do not to the robot animal? When taking a virtual nature walk through a DVD movie of a desert or mountain environment, can people enact the pattern of movement away from human settlement—and the return? Can people enact the pattern of finding respite from nature using nature in a virtual environment when the harshness of nature is not fully sensed or experienced? Can people enact the pattern of checks and balances by nature in a technological nature environment that, even if it checks us through its programming, still lies within the auspices of human control? The questions are many, and perhaps slightly "rigged" because the patterns deeply involve multisensorial interactions with a physical world that are difficult to even

approximate technologically. But that is the point. If technological nature is a poor approximation of actual nature, and if that leads to our enacting only some or incomplete interaction patterns, we should know that limitation, and know it well.

Conclusion

We began with a seemingly simple question: How will we as a species adapt to technological nature? The question is of central importance because people often look at environmental destruction and technological developments and say something like "We'll adapt, don't worry, we'll be fine." I have argued in this chapter we will adapt, but that we should still worry because it is likely that we will not be fine.

My argument had the following structure. (i) Adaptation can be beneficial to a biological or social system, but it can also be harmful (or neutral). (ii) A system well adapted to its environment gains no moral claim. (iii) Adaptation refers broadly to a system's adjustment to its environment and occurs through a wide range of overlapping processes and mechanisms, which include homeostasis, acclimatization, addiction, habituation, equilibration, assimilation, and accommodation, along with the more standard account of biological evolution. (iv) In assessing whether an adaptation benefits or harms a system, the time frame must be specified, for what appears as a benefit (or harm) over a short time frame can become a harm (or benefit) over a longer time frame. (v) Five time frames are useful in assessing the benefits or harms to an adapting system: Level 1 harms last from milliseconds to one month; Level 2 harms last between 1 month and a lifetime; Level 3 harms last between 1 and 10 generations; Level 4 harms last between 100 and 500 generations; and Level 5 harms last over 500 generations. (vi) It is possible that given enough time (e.g., 500 or 5,000 generations) that some harms can disappear because a species changes into another species with different needs for its well-being, but it is virtually impossible to specify a priori for humans which harms can disappear, or how long it would take. (vii) To assess the benefits or harms of technological nature, and of human adaptation to increasingly sophisticated forms of technological nature in the years to come, we need to account for not only direct harms, but the less tractable harms of unfulfilled

flourishing. (viii) A *nature language* has the potential to give voice to both types of harms, especially harms of unfulfilled flourishing. And (ix) the "vocabulary" of a nature language, *interaction patterns*, can be used as benchmarks for assessing the adequacy of current forms of technological nature, and for designing more successful forms in the years to come.

I do not accept the argument that we can simply adapt our way out of our problems. I granted that maybe in 10,000 years or more, it is unknown what our species will look like, and whether all the problems I speak of, in terms of the direct harms and the harms of unfulfilled flourishing, will exist in the way I have cast them here. I think many will. But even that does not matter, because we should not be making choices now based on harms that may or may not disappear 10,000 or 100,000 years into the future. There would be too much human suffering and harms of unfulfilled flourishing in the years between now and then to justify that choice.

Over a hundred years ago, in 1909, E. M. Forster wrote a short story, "The Machine Stops," where he described a future time when people live underground, detached from the natural world, and connected to one another only through the Machine. Forster's conception of the Machine was as an omnipotent, global technological entity that moderated and provided for all bodily and emotional needs of human beings. People became dependent on the Machine and learned to fear and often despise nature. In one early scene, Forster has a mother talking with her son by videoconference. The son says that he yearns for the actual experience of his mother and not the technologically mediated encounter. He tells his mother: "Men made it [the Machine], do not forget that. Great men, but men. The Machine is much, but it is not everything. I see something like you in this plate, but I do not see you. That is why I want you to come. Pay me a visit, so that we can meet face to face, and talk about the hopes that are in my mind" (Forster 1997, p. 140). Along similar lines, Forster writes: "He [the son] broke off, and she [the mother] fancied that he looked sad. She could not be sure, for the Machine did not transmit nuances of expression. It only gave a general idea of people—an idea that was good enough for all practical purposes" (p. 141). Through this story, Forster shows how the technological experience becomes "good" in the sense of "good enough" for basic

functioning rather than good based on deeper capacities for humans to experience and to flourish.

We are a technological species. We will continue to design and build technological nature. If designed well, technological nature will offer substantive nature-like experiences. But I believe that technological nature, like Forster's Machine, will always result in a diminished experience compared to its natural counterpart. If that is true—and the results of my collaborative psychological research described in this book support that proposition—then we should employ technological nature as a bonus on actual nature, not as its substitute. Otherwise, we will come to believe, as we have to some degree already, that the "good enough" is the "good."